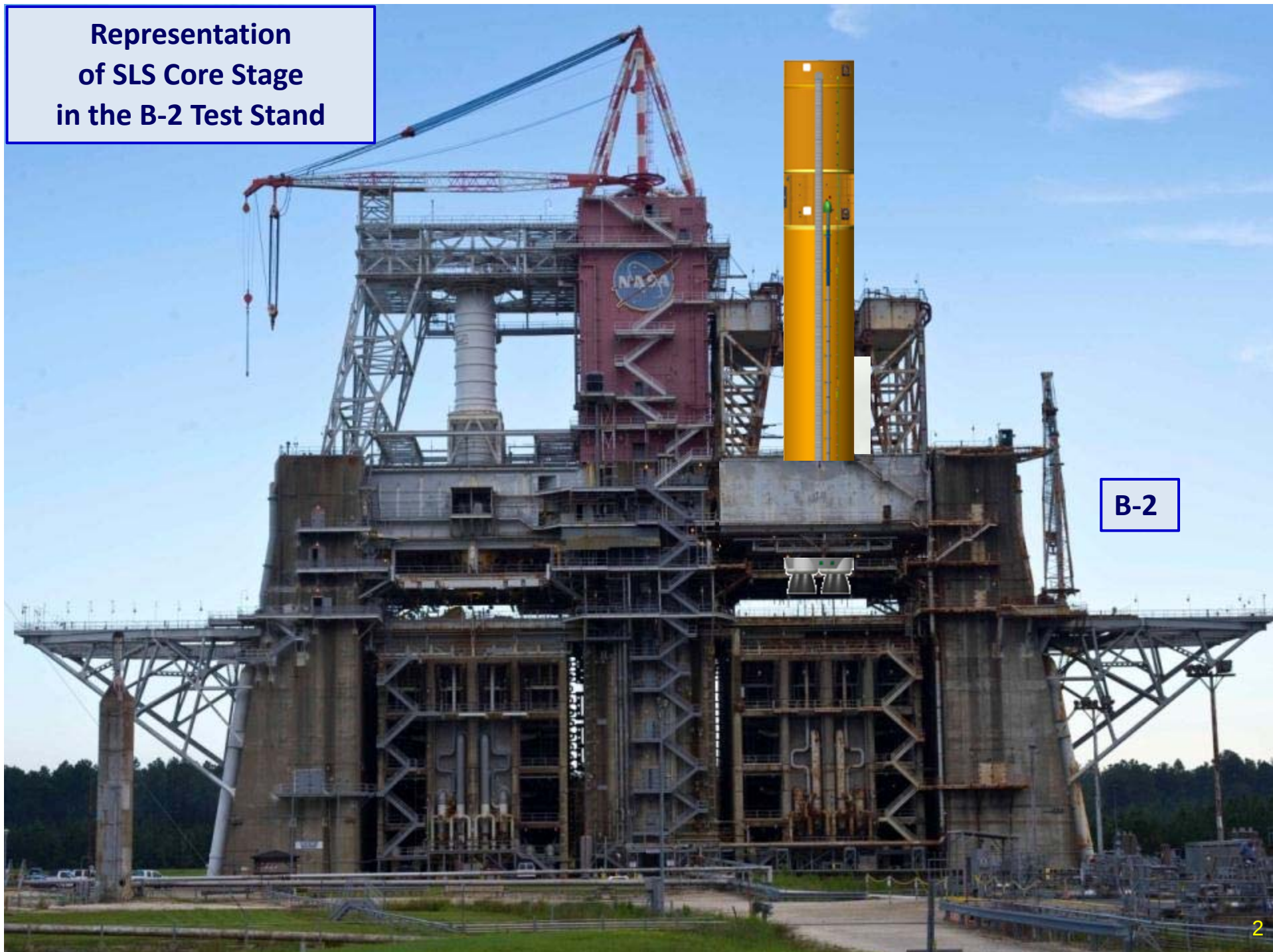


November 06, 2013



**Nick Nugent & Tom Jacks**  
*Engineering and Test Directorate*  
EA32  
*NASA Stennis Space Center*

**Representation  
of SLS Core Stage  
in the B-2 Test Stand**



**B-2**



# SLS Core Stage in the B-2 Test Stand

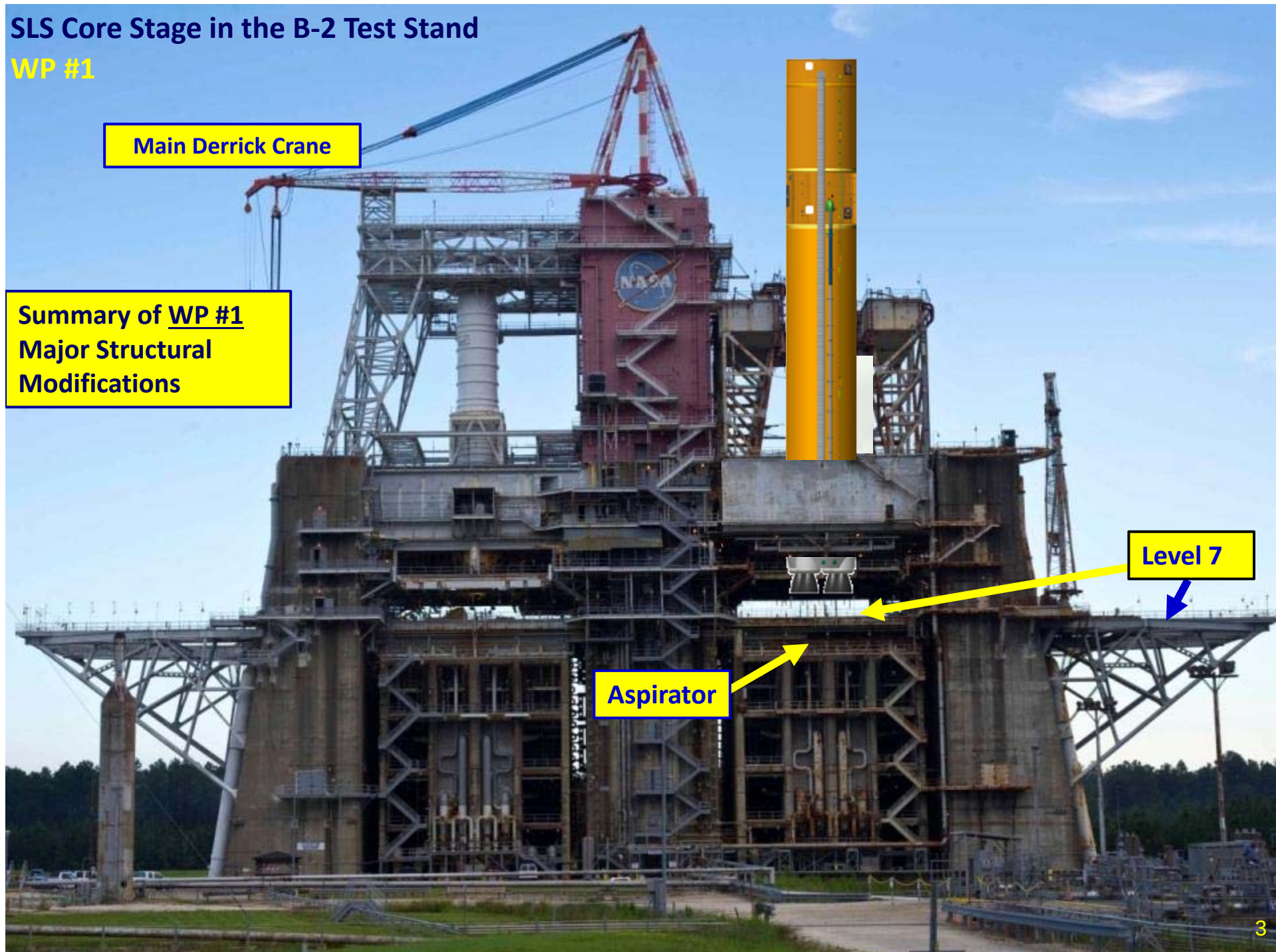
## WP #1

Main Derrick Crane

Summary of WP #1  
Major Structural  
Modifications

Level 7

Aspirator





# SLS Core Stage in the B-2 Test Stand

## WP #1 & WP #2

Main Derrick Crane

Summary of WP #1  
Major Structural  
Modifications

Summary of WP #2  
Major Structural  
Modifications

"Battleship"  
Booster Support Frame

Level 8

Level 7

Aspirator

Flame Deflector  
(Tension Rods)

Ancillary Structures:  
• Platforms & Stairs  
• Tie-Down Tendons

Basement &  
Sub-Basement



# SLS Core Stage in the B-2 Test Stand with New Superstructure

Main Derrick Crane

Top of Stage  
Core Stage Access

Intertank Region  
SLS Weight/Thrust  
Takeout Elevation

Existing MPTA  
Structure

Summary of WP #1  
Major Structural  
Modifications

Summary of WP #2  
Major Structural  
Modifications

Summary of WP #3  
Major Structural  
Modifications,  
Mechanical  
Restoration and  
Electrical Restoration

"Battleship"  
Booster Support Frame

Aspirator

Ancillary Structures:  
• Platforms & Stairs  
• Tie-Down Tendons

Level TBD

Level 18

Level 16

Level 11

Design Concept for  
Upper Superstructure

100 ft

Level 8

Level 7

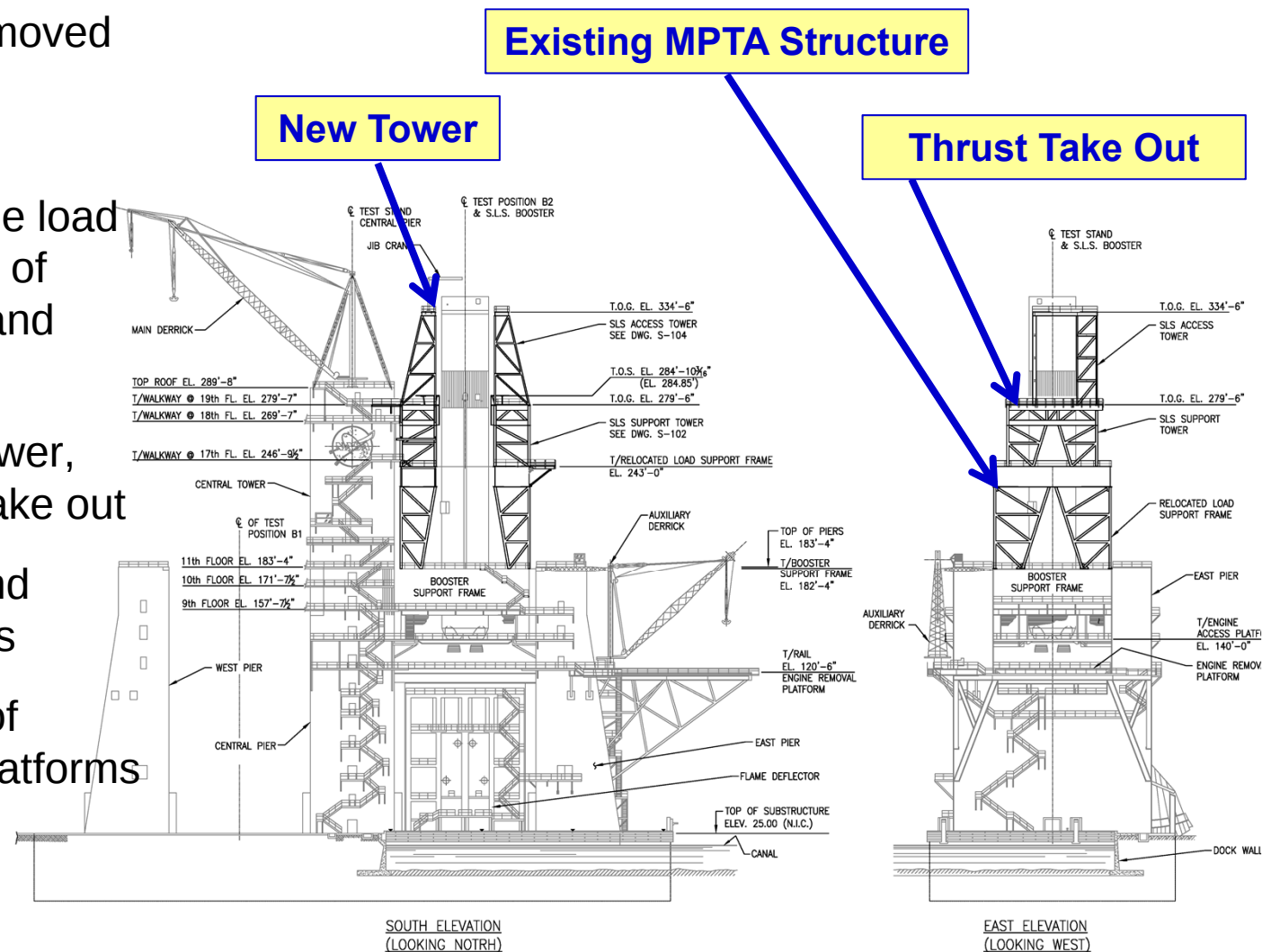
Flame Deflector  
(Tension Rods)

Flame Deflector  
(Segment Repairs)

Basement &  
Sub-Basement

## ◆ Structural Buildout

- Relocate existing MPTA structure will be moved 20' 3" north
- Add bracing and supports (increase load bearing capacity) of MPTA structure and battleship
- Construct new tower, including thrust take out
- Includes stairs and ladders for egress
- Includes design of special access platforms for vehicle





# Plan View: MPTA Structure "Corvette" Above Battleship



Battleship (Level 11)



Existing MPTA  
Structure



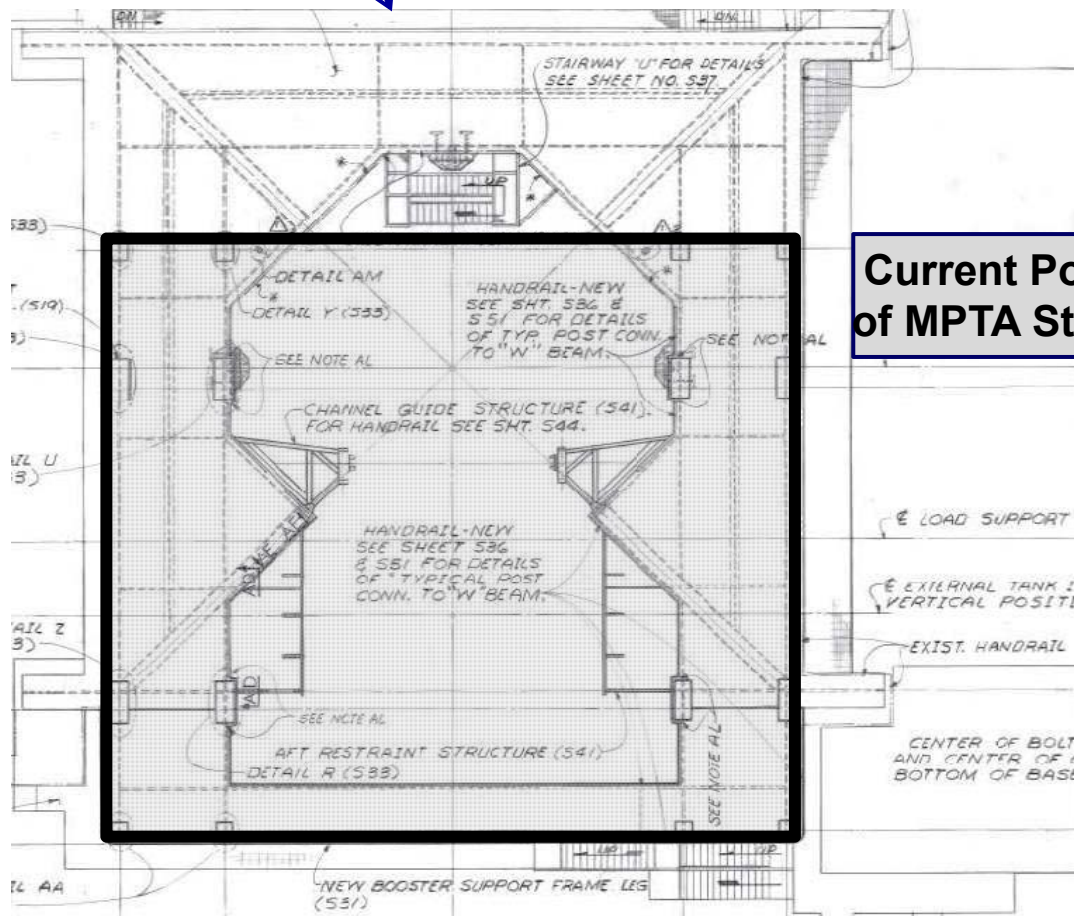
South Elevation

Level 16 - "Corvette"

Level 11

Weight of MPTA  
Structure:  
1.161 Mlbs

Current Position  
of MPTA Structure



# Plan View: MPTA Structure "Corvette" Above Battleship



Battleship (Level 11)



Existing MPTA  
Structure



Battleship

Level 16 - "Corvette"

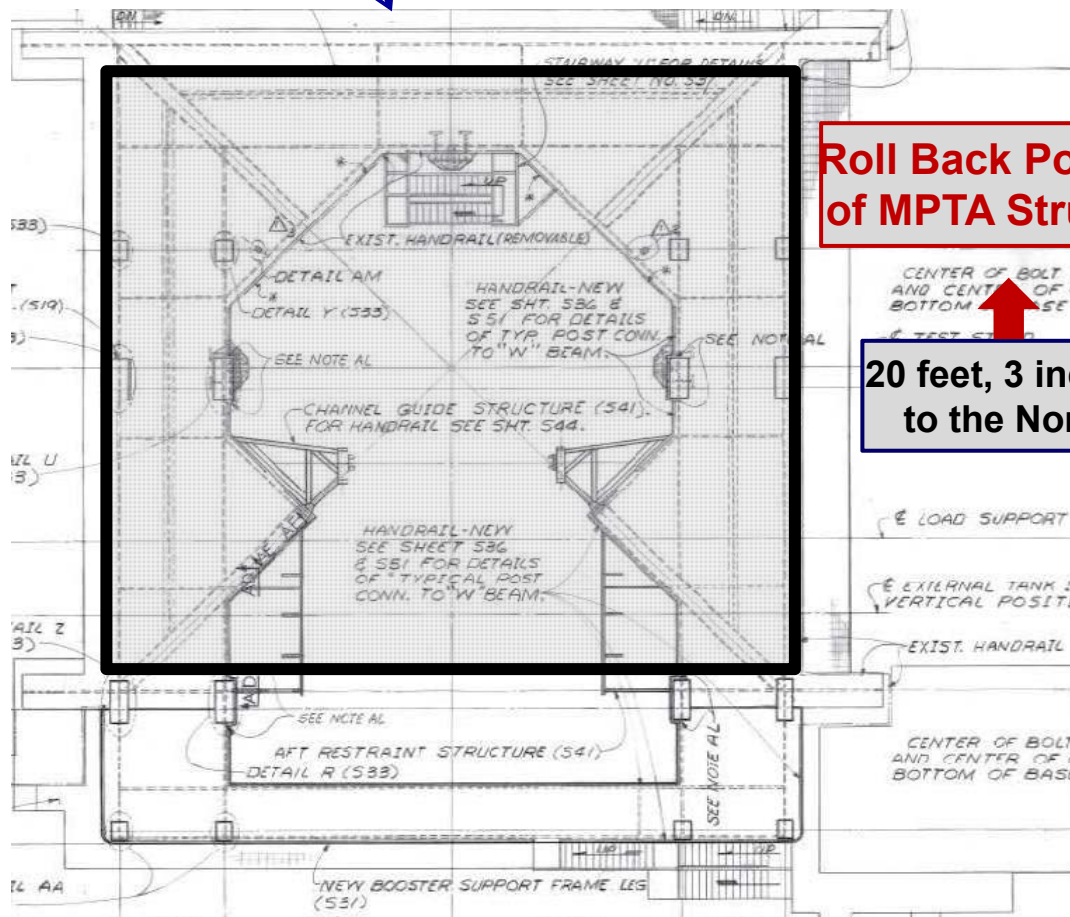
Level 11

Weight of MPTA  
Structure:  
1.161 Mlbs

South Elevation

Roll Back Position  
of MPTA Structure

20 feet, 3 inches  
to the North





# Plan View: MPTA Structure "Corvette" Above Battleship



Battleship (Level 11)



Existing MPTA  
Structure



Battleship

Level 16 - "Corvette"

Level 11

Weight of MPTA  
Structure:  
1.161 Mlbs

South Elevation

Roll Back Position  
of MPTA Structure

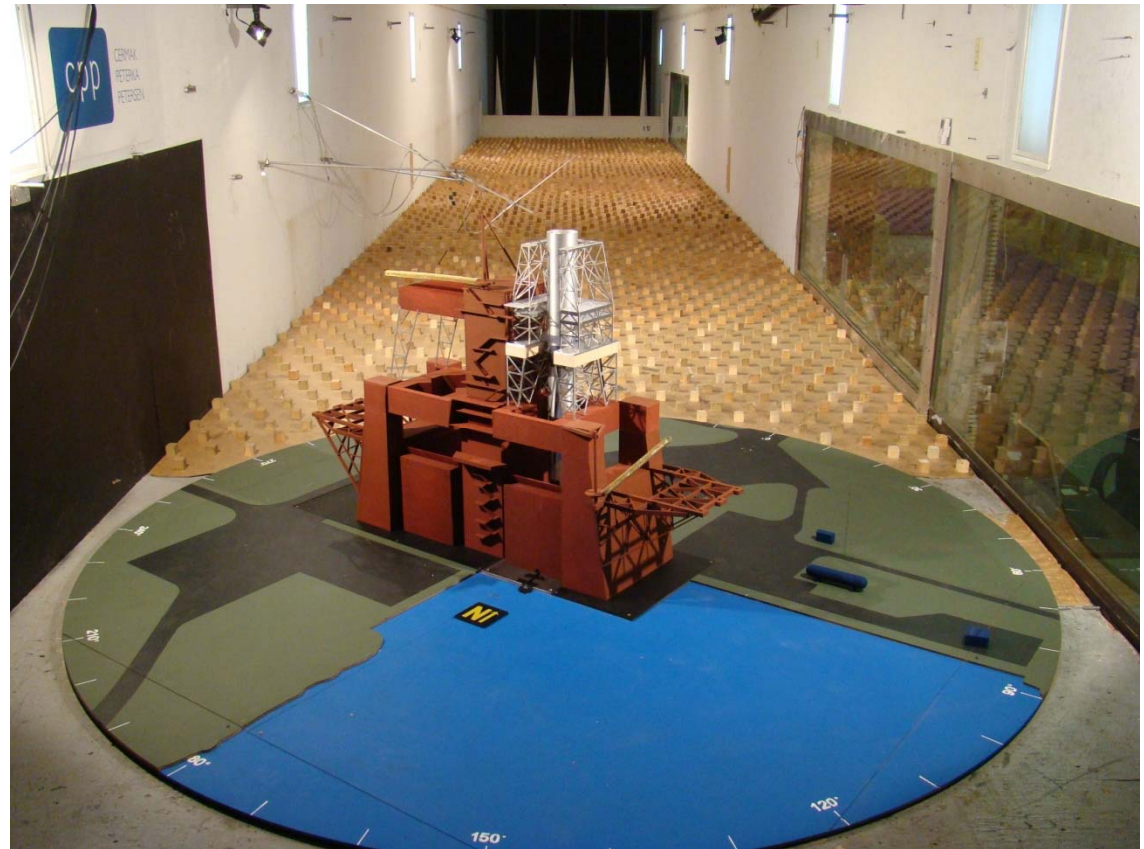
20 feet, 3 inches  
to the North

## Why Consider Rollback?

- Anticipated **cost savings** of \$2+ M compared with building out the existing MPTA structure to accommodate the Core Stage.
- Anticipated **schedule savings** of 1-3 months.
- A Note on **Risk**: PEI's lead structural engineer has designed numerous successful rollbacks of larger, heavier, and more top heavy "precipitators" for the pulp and paper industry.

## Structural Wind Tunnel Testing

- Scale model of B-2 was tested in wind tunnel at CPP Wind Engineering, Fort Collins, CO
- Test results used in accordance with Method 3 of ASCE7-05 to calculate forces due to wind load
- Forces were significantly lower than forces calculated strictly analytically
- Resulted in cost savings greater than the cost of testing (\$100K) and increased margin in design
- Effort being made to return model to SSC





| <b>B-2 Restoration and Buildout/STE Work Flow Timelines</b>                                                                                                                                                                                                                                                                                                                                                                                                                         |        |    |    |    |                                                                                                               |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----|----|----|---------------------------------------------------------------------------------------------------------------|----|----|----|----------------------------------------|----|----|----|----------------|----|----|----|----------------|----|----|----|--------|----|----|----|-----------------|----|----|----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | FY2012 |    |    |    | FY2013                                                                                                        |    |    |    | FY2014                                 |    |    |    | FY2015         |    |    |    | FY2016         |    |    |    | FY2017 |    |    |    |                 |    |    |    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Q1     | Q2 | Q3 | Q4 | Q1                                                                                                            | Q2 | Q3 | Q4 | Q1                                     | Q2 | Q3 | Q4 | Q1             | Q2 | Q3 | Q4 | Q1             | Q2 | Q3 | Q4 | Q1     | Q2 | Q3 | Q4 | Q1              | Q2 | Q3 | Q4 |
| <b>SLS Program Stages Element Milestones</b>                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |    |    |    | SRR/SDR<br>Aug '12                                                                                            |    |    |    | PDR<br>May '13                         |    |    |    | CDR<br>Nov '14 |    |    |    | DCR<br>Oct '15 |    |    |    |        |    |    |    | EM-1<br>Dec '17 |    |    |    |
| <b>Planned RS-68 Tests</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |    |    |    | ▼▼                                                                                                            |    |    |    | ▼▼▼▼                                   |    |    |    | ▼▼▼▼           |    |    |    | ▼▼▼▼           |    |    |    |        |    |    |    |                 |    |    |    |
| Project Management Plan Development                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Docs   |    |    |    |                                                                                                               |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>B-2 Restoration</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |    |    |    |                                                                                                               |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>Demolition</b> (Levels 7-8, 11-16, Battleship)                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |    |    |    | Aug '12 ▼ Construction Mar '13 ▼                                                                              |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>WP#1</b> (Level 7 Fixed and Rolling Decks, Aspirator, and Derrick Crane)                                                                                                                                                                                                                                                                                                                                                                                                         |        |    |    |    | Sep '12 ▼ Design P Nov '12 ▼ Construction Nov '13 ▼ Apr '14 ▼<br><small>Derrick Crane</small>                 |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>WP#2</b> (Level 8 and 8-1/2, Battleship, Braces, Basement, Deflector Lateral Support, Major Structural Demo, Stairs and Platforms, Tie Down Tendons)                                                                                                                                                                                                                                                                                                                             |        |    |    |    | Jan '13 ▼ Design Procu Mar '13 ▼ Construction Feb '14 ▼                                                       |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>Mechanical Package</b><br>• Piping Systems<br>• Valve and Component Triage and Repair                                                                                                                                                                                                                                                                                                                                                                                            | WP#3   |    |    |    | Nov '12 ▼ Req Dev Aug '13 ▼ Design P Components Nov '13 ▼ Nov '15 ▼ Feb '15 ▼<br><small>Critical Path</small> |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>Electrical Package</b> (High Voltage and 28VDC)                                                                                                                                                                                                                                                                                                                                                                                                                                  | WP#3   |    |    |    | Jan '13 ▼ Req Dev Aug '13 ▼ Design P Nov '13 ▼ Nov '14 ▼ Feb '15 ▼<br><small>Critical Path</small>            |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>Miscellaneous Restoration</b> (Bunker Repair, Temporary Parking Lot, Paint Soft Core, etc.)                                                                                                                                                                                                                                                                                                                                                                                      |        |    |    |    | Mar '13 ▼ Design P May '13 ▼ Jun '14 ▼                                                                        |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>B-2 Facility Buildout</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |    |    |    |                                                                                                               |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>Requirements Development</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |    |    |    | SLS Baseline Requirements ▼ Apr '13                                                                           |    |    |    |                                        |    |    |    | ▼ CDR          |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>Structural</b> (SLS Superstructure, Reposition Existing MPTA Structure at Levels 11-16, Flame Deflector Segment Repair)                                                                                                                                                                                                                                                                                                                                                          | WP#3   |    |    |    | Aug '13 ▼ Design P Nov '13 ▼ Aug '14 ▼                                                                        |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>Mechanical Package</b> (Piping Systems)                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |    |    |    | Feb '14 ▼ Design P Mar '14 ▼ Nov '14 ▼ Aug '15 ▼<br><small>Critical Path</small>                              |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>Electrical Package</b> (High Voltage and 28VDC)                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |    |    |    | Feb '14 ▼ Design P Mar '14 ▼ Nov '14 ▼ Aug '15 ▼<br><small>Critical Path</small>                              |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>B-2 STE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |    |    |    |                                                                                                               |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>Structural, Mechanical, Electrical Packages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |    |    |    |                                                                                                               |    |    |    | Jan '15 ▼ Design P Feb '15 ▼ Jan '16 ▼ |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <b>B-2 Activation/Test</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |    |    |    |                                                                                                               |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |
| <div style="text-align: right;"> <p>Sept '16 - CS Delivery</p> <p>Oct '16 - Tanking Test</p> <p>Nov '16 - Hot Fire Test #1</p> <p>Dec '16 - Hot Fire Test #2</p> <p>Jan '17 - Post Test C/O and Repair</p> <p>Feb '17 - CS Removal</p> </div> <div style="text-align: center; margin-top: 10px;"> <span style="background-color: red; color: white; padding: 2px 10px;">Activation</span> <span style="background-color: blue; color: white; padding: 2px 10px;">Test</span> </div> |        |    |    |    |                                                                                                               |    |    |    |                                        |    |    |    |                |    |    |    |                |    |    |    |        |    |    |    |                 |    |    |    |









































## WP #1: Installation of Aspirator Girders at Level 7





## WP #1: Aspirator Main Girders Installed



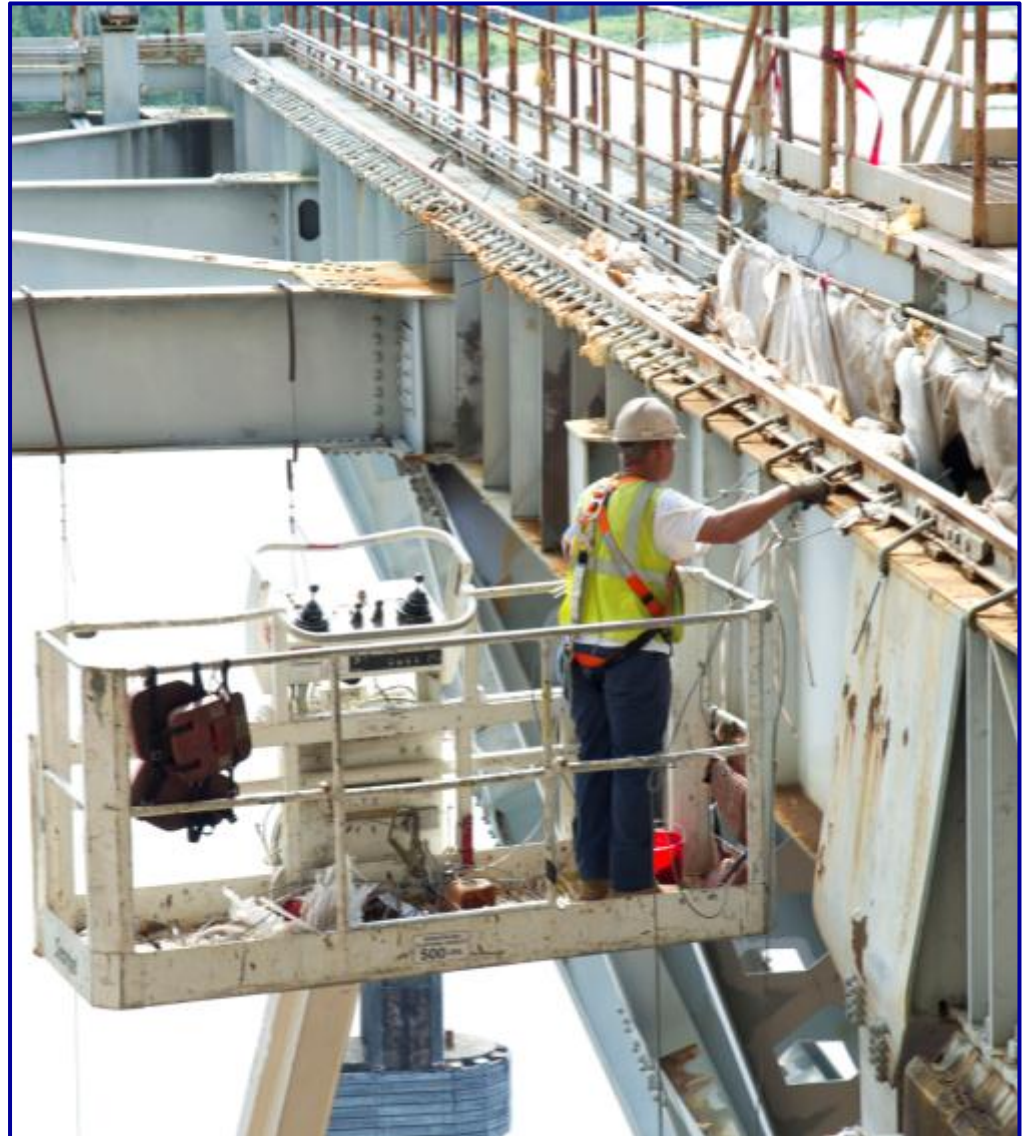


## WP #1: Aspirator Corner Section Installation



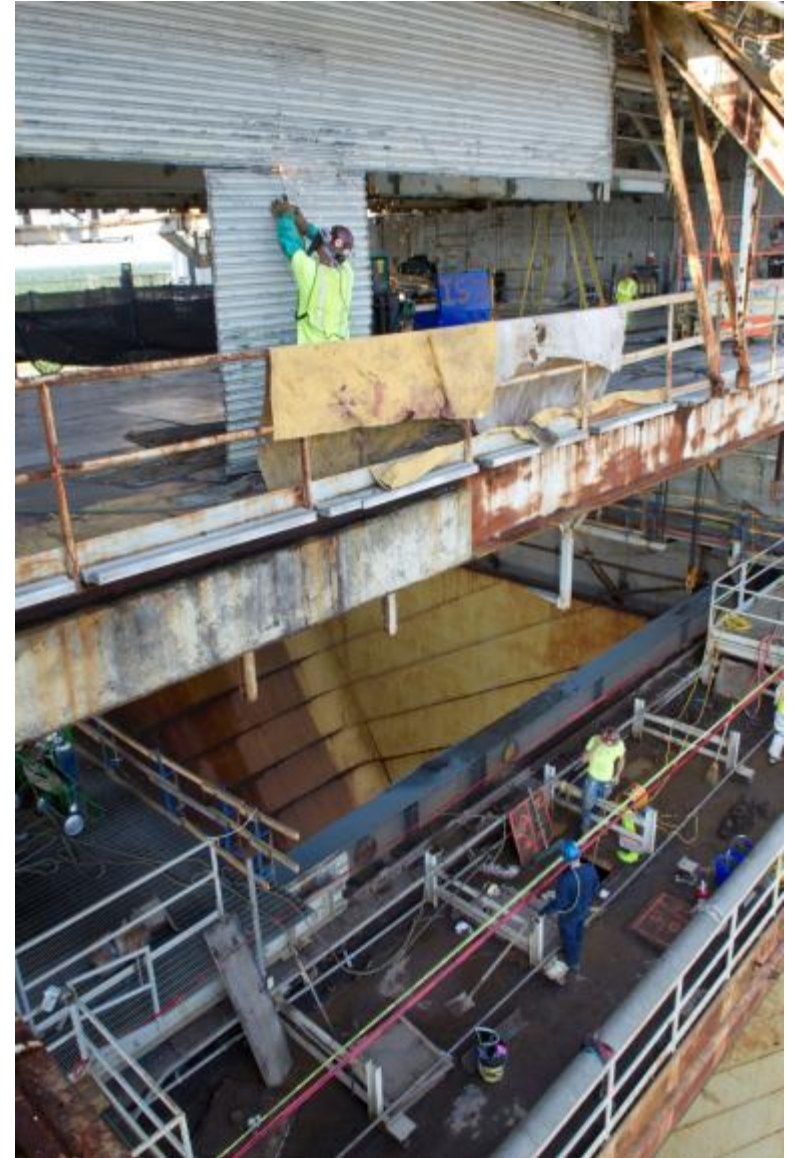


## WP #1: Level 7 Diving Board Restoration





## WP #2: Coiling Door Demolition on Level 8





## Busy Stand!



# Questions